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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Lubrication of
Natural Gas Machinery

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LUBRICATION

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Lubrication of Natural Gas Machinery

Some five years ago the late Judge Ames* stated that:

"Approximately two billion feet of gas are being blown into the air every day. In 1930 there were 5,448,000 domestic consumers of natural gas who used a total of 376,407,000,000 feet or a little more than 1,000,000,000 feet per day. We are, therefore, blowing into the air approximately twice as much natural gas as is being used by 5,448,000 domestic consumers. This is a three-fold waste. It wastes the gas itself, but the gas which is being wasted is bringing to the surface an excessive quantity of oil which results in wasteful use and inadequate price, and, in addition, this wasted gas is bringing to the surface its natural gasoline content, which in turn is crowded into an unwilling market to the detriment of the industry as a whole."

THE significance of waste of this nature is so important as to be worthy of renewed consideration, for to many it has always been more or less obscure. In fact, to some it would not appear as waste as it involves a commodity or by-product to which no definite cost of production can be attached; others, however, thinking in terms of domestic or manufactured gas might attach a quite abnormal value.

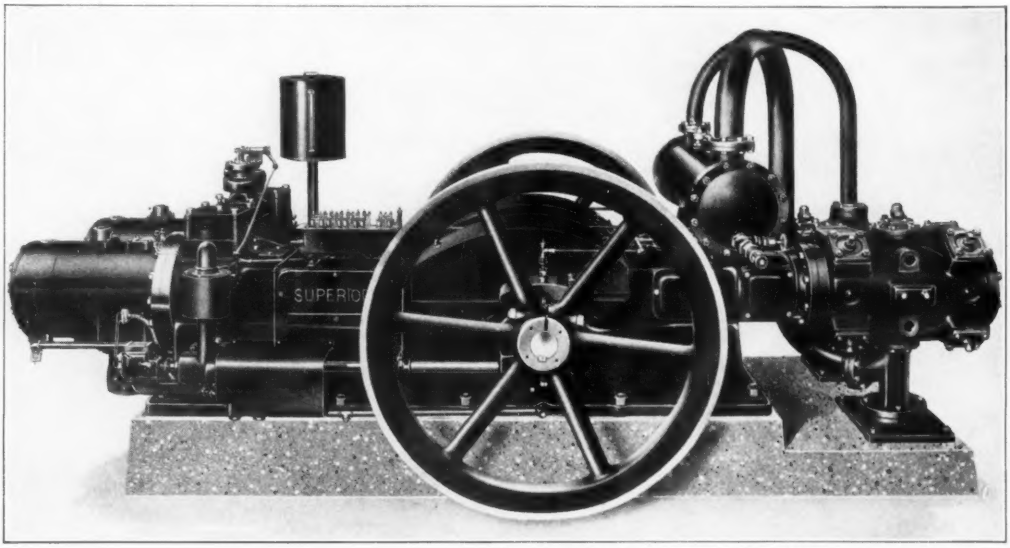
*C. B. Ames, V.P., The Texas Company, presented at a National Conference on the Relation of Law and Business, under the Auspices of the School of Law and the School of Commerce, Accounts, and Finance of New York University, October 26 and 27, 1931.

The true relation of natural gas at its source must be evaluated in terms of motor fuel or gasoline. In other words, that product known as casinghead gasoline wherein the natural gas is compressed and otherwise treated to develop a fluid fuel comparable in anti-knock qualities to the more generally used distilled product.

The manufacture of gasoline from casinghead gas has become a virtual industry in itself in the oil field country of the southwest, and certain parts of California. It has become so organized as to be able to produce approximately 10% of the total gasoline consumed annually in the United States. To do this some 1,776,172,000,000 cubic feet of natural gas are used at the source, with an average yield of approximately .86 of a gallon of natural gasoline per 1,000 cubic feet treated.

The plants will range in size from the single well type compressing some 10,000 cubic feet of gas per day to produce from 75 to 100 gallons of gasoline; to the central station operating some 15 to 20 compressors, handling several million cubic feet of gas and producing 40 to 50 thousand gallons of gasoline per day. Most of these plants are complete in every detail, including highly specialized machinery designed particularly for the work involved. This will include pump jacks for pumping crude oil, vacuum pumps to draw gas from the wells and increase its flow, gas engines for power generation and compressor operation, and the compressors for actual conversion of the gas. In addition, many plants will also operate a well equipped machine

shop, electric lighting units and a complete water system, being thereby self-containing with natural gas as their primary source of power as well as income. All are usually located as centrally as possible with respect to the well or wells from which they draw their gas, in also vary. As a rule the single cylinder installations will range from 80 to 125 h.p.; the twin-cylinder jobs are more powerful, however, normally ranging from 180 to 250 h.p., although in larger plants they may even go as high as 440.



Courtesy of The National Supply Co. of Delaware, Superior Engine Division

Fig. 1—A Superior horizontal direct gas engine driven duplex compressor. Lubrication of the main and connecting rod bearings and cross-head is maintained by a gear type oil pump driven from the layshaft, which takes oil from the sump directly underneath the crankshaft and pumps it to the overhead filter and reservoir. The oil flows by gravity from this elevated reservoir to the respective bearings and thence back to the sump. An independently located force feed lubricator serves the power and compressor cylinders as well as the governor.

order to reduce piping expense and cost of handling their raw material. In addition, one will also find booster stations located in many parts of the oil fields involving a gas engine driven compressor. These stations pump the casinghead gas from the leases to the plant or central station where the gasoline is produced. It is at such points that the vacuum pump is of service as an assistant to gas production.

It is more profitable to use a number of small compressors in the average casinghead gasoline plant than one large unit, even though actual operation of the latter might oftentimes be more economical. On the other hand, in case of breakdown the entire plant would be out of service, whereas shut down of one, or even more compressors, in a multiple unit plant would involve but little serious disruption of production provided the remaining machines could carry the resultant overload.

A unit consists of a single or twin-cylinder two-stroke cycle gas engine, directly connected or driving through a belt, to a single cylinder or duplex type double acting compressor. Although a variety of valves are used in compressors of this type, the plate valve is most widely preferred. Engine and compressor sizes

THE GAS ENGINE

This machine, as the prime mover in the casinghead gasoline plant, must be most carefully considered from the viewpoint of lubrication. It is an extremely flexible type of machine and adapted to a wide variety of operating conditions. It is built to operate either horizontally or vertically at comparatively low speeds, developing high power output in proportion to the speed. Either the trunk piston or crosshead type of design can be used. In the former the connecting rod is attached at one end to the wrist pin in the piston, any side thrust caused by angularity of the rod being transmitted through the piston to the cylinder liner. In the crosshead type engine, however, the connecting rod is attached to a crosshead which travels in guides, the crosshead in turn being connected to its companion piston. As side thrust is developed it is taken up by the crosshead guides. These latter must, therefore, be properly lubricated to enable minimum friction and wear between their contact surfaces and the slippers or sliding elements of the crosshead.

The two stroke cycle gas engine predominates in the casinghead gasoline plant. This type of engine is noteworthy for its simplicity in de-

sign, and freedom from valve troubles. Normally two separate and distinct lubricating systems can be employed, viz.:

1. Mechanical force feed for cylinders by means of an external lubricator, with oil circulated to the bearings by a suitable pump located in the crankcase.
2. Mechanical force feed to cylinders, with splash lubrication of bearings.

It is perfectly obvious that the gas engine will function most satisfactorily and show a longer period of useful life when it is effectively lubricated. On the other hand, the best of design will be of little avail in lengthening the life of such an engine if the quality of lubrication and the means of application are not properly studied. To the credit of the engine builder it may be said that this has been fully realized.

In order to maintain effective lubrication the operating factors which impose certain duties upon the oils, as well as the various lubricated parts of the engine must always be fully understood by the operators. Simplicity of design, and ready access to all parts have been accepted as fundamental requirements by the builders of the modern gas engines, this is why such careful attention has been given to include completely automatic lubrication, doing away with all complications, to assure positive distribution of oil to the various parts.

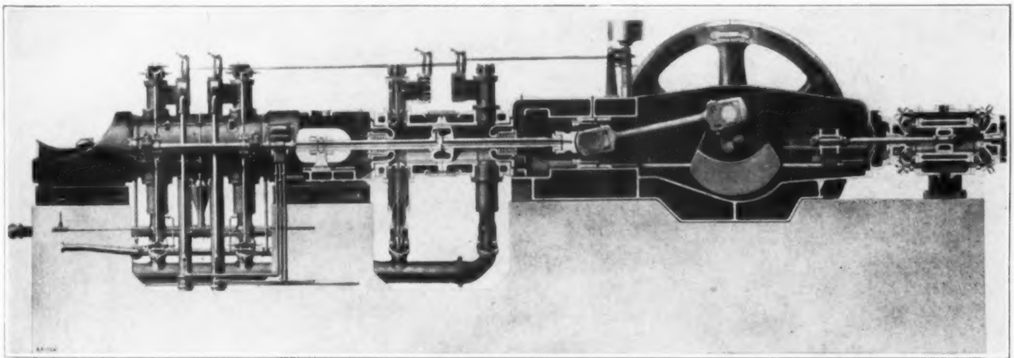
The fact that he is dealing with standardized methods of lubrication should not relieve the operator of realizing that probably no other type of machine can be damaged so easily and quickly by faulty lubrication as the modern gas engine. This applies particularly to the use of inferior oils. While the average cost per unit of power to lubricate any such engine is small, this cost can very quickly be increased beyond all reason through abnormal wear and increased maintenance costs, by the use of an unsuitable grade of lubricating oil which will not afford the necessary protection.

The specific conditions involved are of interest, for we are concerned with parts in motion with respect to each other under widely varying speeds, loads and temperatures. These coupled with the coefficients of friction of the materials used in the average engine, would seem to require a number of different grades of oil to insure its operation. Judicious selection of products especially refined to meet such conditions has proved, however, that from one to two oils will serve the purpose.

There are, of course, plants where more will be necessary, the constructional conditions dictating too wide a viscosity range for any one lubricant. Investigation has indicated that even this condition can often be eliminated, especially on small sized engines, if the means of application is studied. In other words, it is perfectly practicable to refine lubricating oils which, provided an engine is properly cooled, will meet the intensive duty involved in the cylinders, and still be of the right viscosity to protect these parts at the prevailing bearing temperatures.

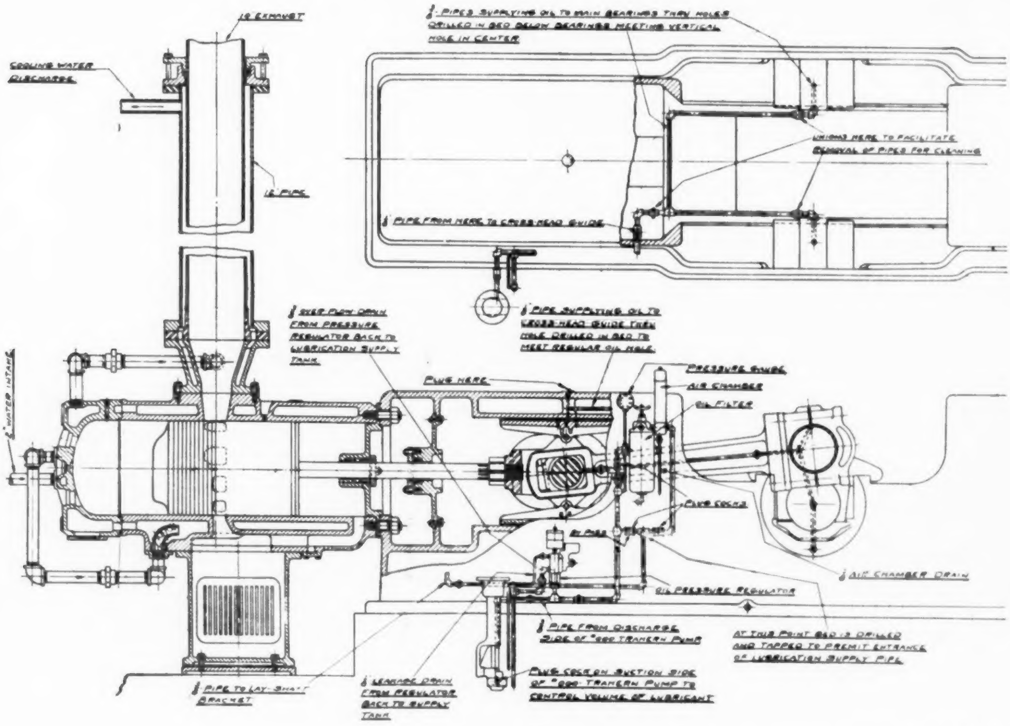
Gas engine lubrication must be positive and any oil used must be capable of developing a sufficiently tenacious lubricating film to also withstand the operating pressures. The selection of lubricants for a gas engine plant should, therefore, be made strictly on the basis of quality, involving chemical characteristics to insure properly refined oils containing no impurities, and on viscosity, to insure the proper grade. Neither color nor density qualify as special properties in the selection of such an oil, although color may be significant of the degree of refinement.

Excessive friction may result from the use of an oil of either too high or too low viscosity. Too high a viscosity will give a good film but the internal friction in the oil may be excessive; conversely, if the viscosity is too low the film may be broken. The physical characteristic,



Courtesy of Worthington Pump & Machinery Corp.

Fig. 2—Sectional view of a Worthington four-cycle double-acting tandem cylinder gas engine. This view shows in detail the relative location of the operating mechanisms, likewise the design of the stuffing boxes to prevent leakage.



Courtesy of Clark Bros. Co.

Fig. 3—Details of the force feed oiling system as applied to a Clark gas engine. It is interesting to note in particular the relative locations of the accessories to the lubricating system, as well as pipe dimensions.

viscosity, therefore, is of supreme importance in the selection of a lubricant, as it is a measure of the ability of the oil to maintain the proper film under the existing conditions of speed, pressure and temperature. This should, therefore, be the basic thought in the preparation of any lubrication recommendation for such machinery.

Cylinder Lubrication

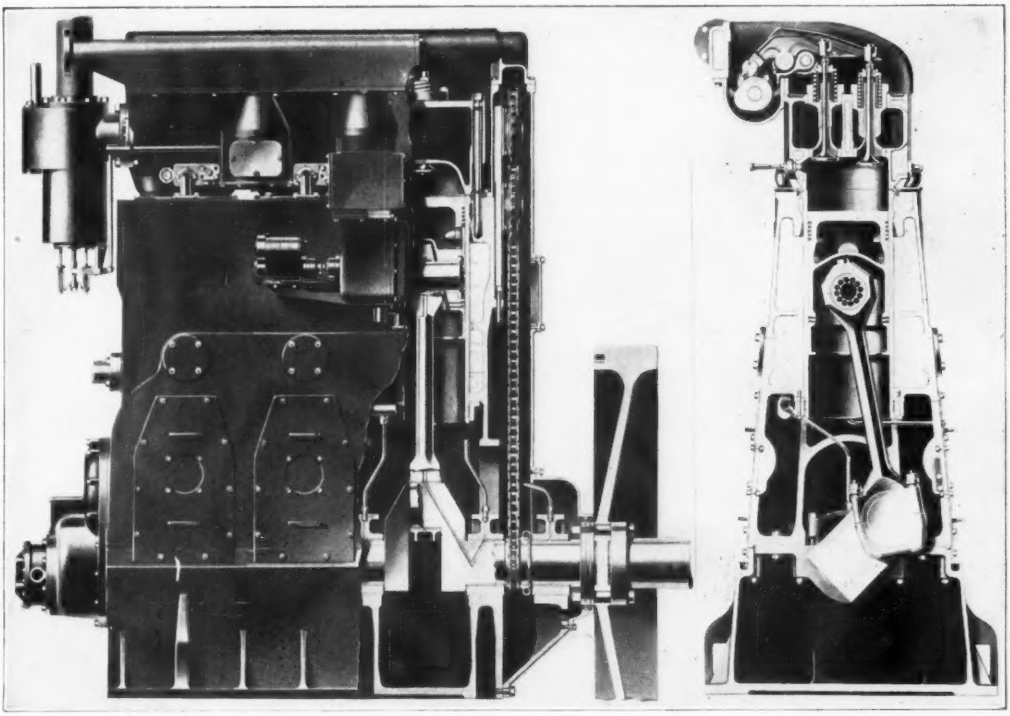
Cylinder liners and piston rings as those parts subjected to the most extreme operating conditions will naturally require the most positive lubrication for their protection. One condition in particular which is entirely foreign to other types of internal combustion engine fuels, involves entrained air.

Air in casinghead gas is one of the greatest sources of trouble in the operation of the gasoline plant, for it markedly affects lubrication of the cylinders. The cause of air in such gas is generally defective casingheads which permit leakage into the lines due to the vacuum which is drawn on the wells. In addition air causes trouble in other ways, to result in decreased production and damage to equipment.

Air mixed with casinghead gasoline vapors, raises the temperature required to extract the gasoline constituents to such a point that the plant cannot properly condense and remove the gasoline. As a result this latter is carried to the engines along with the gas. On the other hand, the compression of the engines is too high to take gasoline gas without pre-ignition. So, when the casinghead gas mixes with its theoretical volume of air in the mixing valve and enters the combustion chamber, the mixture is too rich. This causes excessive heating of the cylinders and pistons from pre-ignition and quick burning of the fuel, thereby destroying the lubricating film on the cylinder walls. The ultimate result is shut-down of the engine due to stuck pistons and rings. The excessive wear which has occurred meanwhile necessitates the reboring of cylinders and installation of new piston rings.

Engines operating under such conditions have been known to become so hot that the spark plugs were melted. So when complaints against lubrication of the gas engines in oil field service arise, it is always well to trace back to the source, for usually the difficulty will be found to be caused by using a fuel too rich in gasoline content and no fault of the lubricating oil.

Another factor which affects the lubrication of gas engines in oil field service involves inadequate cooling water systems and the use

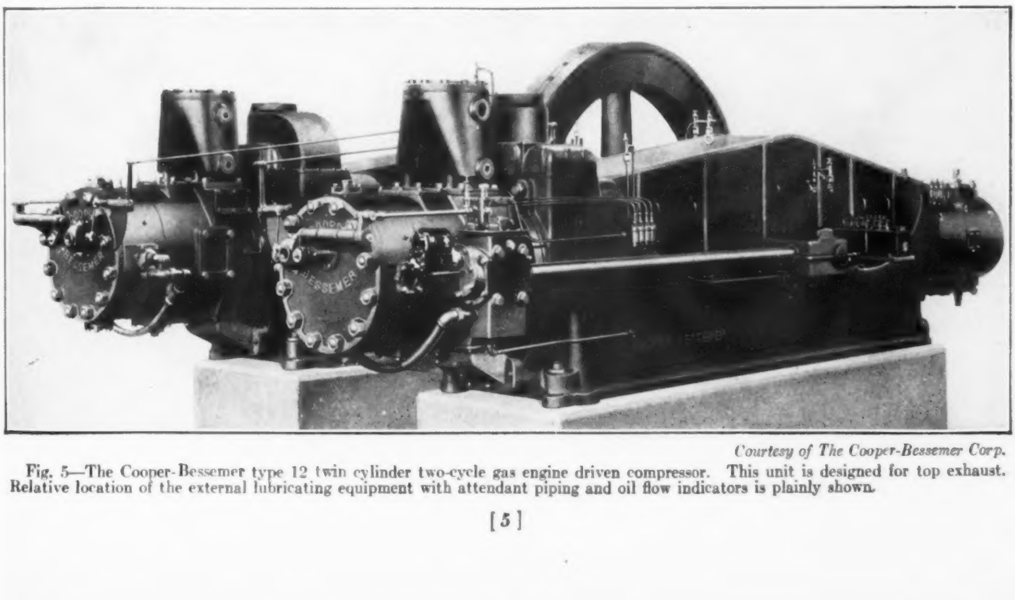


Courtesy of Ingersoll-Rand Co.

Fig. 4—The Ingersoll-Rand gas engine has been designed with particular attention towards rendering lubrication entirely automatic. The above details indicate the working mechanisms of the lubricating system, the necessary piping, the method of sealing, the design of the labyrinth oil throwers to prevent oil leakage, and the drilling of the crankshaft and connecting rods to facilitate positive lubrication of all the bearings. By reason of the location and design of the force feed lubricating pump a dry crankcase is constantly maintained.

of untreated water containing a large percentage of insoluble salts. These latter in the form of calcium and magnesium carbonates have a tendency to deposit scale and form an insulating coating in the water jackets of the engine. This will result in insufficient cooling and excessive operating temperatures, being another cause of pre-ignition, back-firing and destruction of the lubricating oil film on the cylinder walls. Here again metal-to-metal contact between the piston rings and cylinder walls will result, with ultimate seizure of the pistons, but meanwhile considerable power loss due to preignition and back fire will have occurred.

Adequate cooling of the cylinder walls by proper water circulation assures a reduction in temperatures and the maintenance of positive lubrication. Under uncontrollable adverse



Courtesy of The Cooper-Bessemer Corp.

Fig. 5—The Cooper-Bessemer type 12 twin cylinder two-cycle gas engine driven compressor. This unit is designed for top exhaust. Relative location of the external lubricating equipment with attendant piping and oil flow indicators is plainly shown.

conditions, however, the high temperatures encountered should be taken into account when selecting the cylinder lubricant, with prior consideration being given to low carbon residue and an ability to resist breakdown. Oil of low carbon residue assures cleaner cylinders, freedom from stuck rings, better engine operation, a minimum of wear and low maintenance cost. Again, in selecting the lubricant for cylinders, consideration must be given to the condition of the fuel. Should it contain mineral seal oil, moisture, or a percentage of sulphur, a compounded lubricant is preferred as stated elsewhere in this article. In all cases care should always be observed to prevent the use of more oil than is absolutely necessary.

Continuous renewal of the lubricating film, especially where a mechanical force feed lubricator is employed, is added assurance that the above-mentioned conditions will be met, for it enables restoration of lubricant before vaporization or breakdown losses occur sufficiently to develop actual metallic contact. This can only be positively assured, however, provided the oil is of the proper viscosity to resist the reducing effects of heat.

Engine Deposits

Actual formation of deposits in the gas engine will be brought about in much the same manner as in the liquid fuel type of internal combustion engine. There will, however, be but little possibility of this being aggravated by the type of gas used as fuel unless the dust or tar content is comparatively high, when the same results might be expected as occur when a liquid fuel is subjected to incomplete combustion. The detrimental features which may accrue from the use of contaminated gas cannot be overlooked. Not only will they involve fouling of the valves with the possibility of sticking, but also there will be the probability of increased cylinder wear. This will be brought about by accumulation of the foreign matter content of the gas around the piston rings. It is also advisable to watch the condition of the air. In other words, the air intake system must be maintained so that at all times the required quantity of pure air to the engine will be available. In oil field operations generally, large quantities of dust and dirt are encountered and air filters should be used for protection. Particles of solid foreign matter passing in with the air accumulate not only on valve passages but on the valves and around the rings, causing abnormal cylinder wear and valve trouble, to thereby directly influence the lubrication of cylinders and the degree of

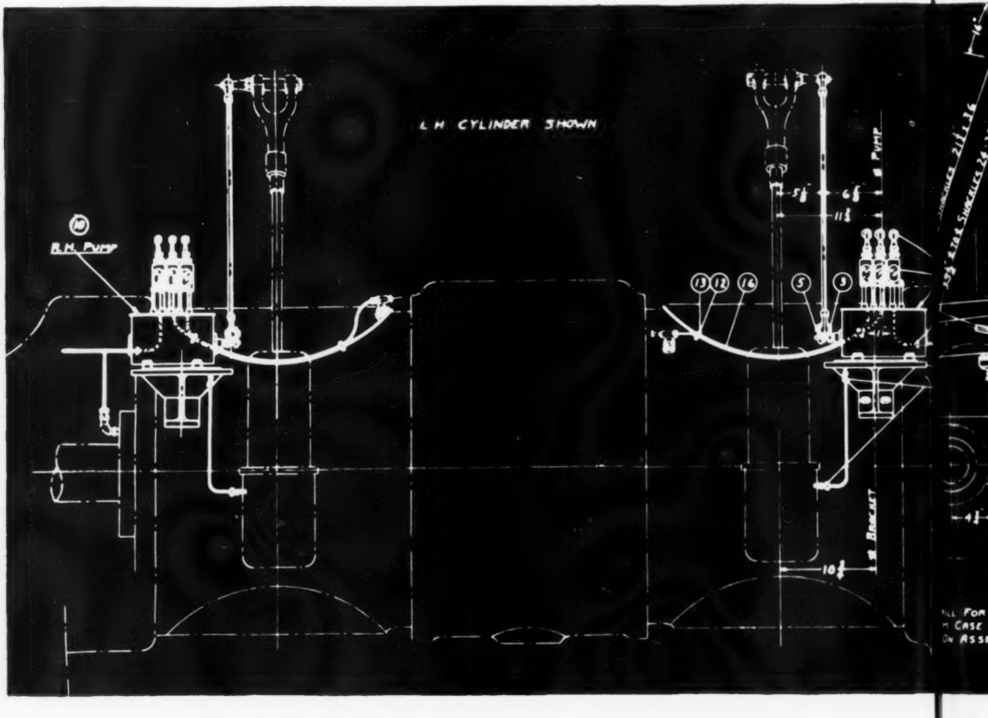


Fig. 6—In contrast with the external view of the lubrication appliances on the Cooper-Bes
for the engine cylinder and piston rods in line detail. MacCord force feed lubricators are used

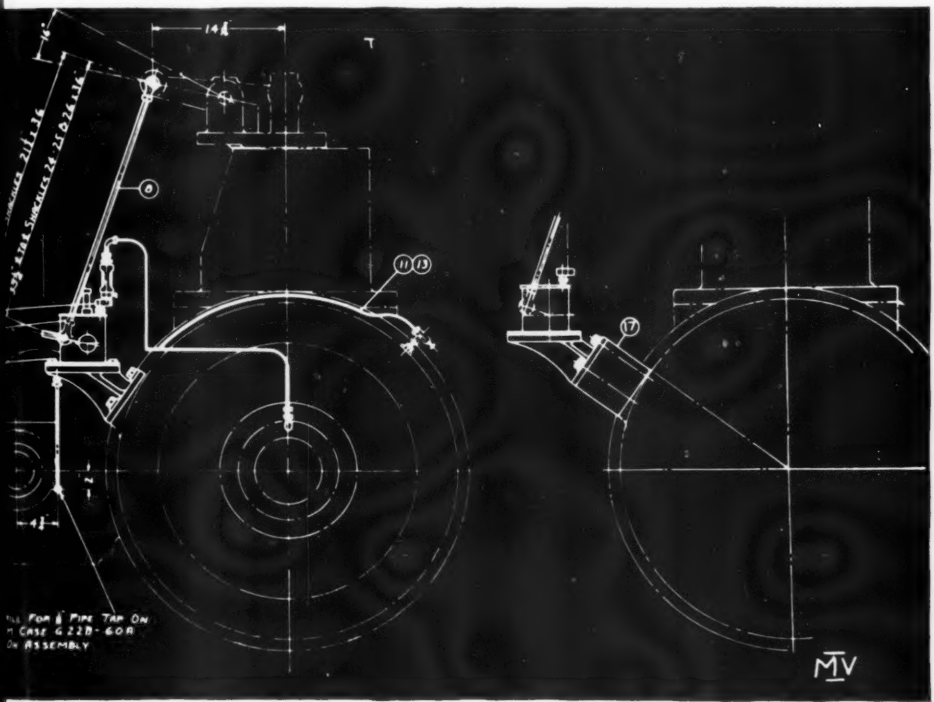
contamination of oil in the lubricating system.

Should an unsuitable grade of lubricating oil be used, it would be logical to expect such formations to be increased by the carbon residue content of the former. Under the prevailing temperatures these formations might develop into hard, abrasive encrustations, although the degree of hardness of the carbon resulting from the lubricating oil will depend upon the base. The actual percentage of carbon residue content, however, will be indicative of the manner and degree of refinement to which the lubricating oil has been subjected. Unfortunately, there is no oil which will not deposit some carbon; on the other hand, there is a surprising difference in the nature and quantity of this carbon which will be developed by different oils.

As already suggested, the oil feeds should be carefully controlled. Otherwise an excess of oil fed to the cylinders may bring about leaky valves due to a certain amount of oil becoming carbonized thereon. Likewise, an excess delivered to the piston rod stuffing box may cause leakage and improper functioning of the packing due to abnormal wear. Carbonaceous matter, being relatively sticky in the early stages of its formation, will also tend to adhere to the piston rings, thereby causing them to become inoperative; furthermore, it will tend to destroy the lubricating film and result in scored cylinders.

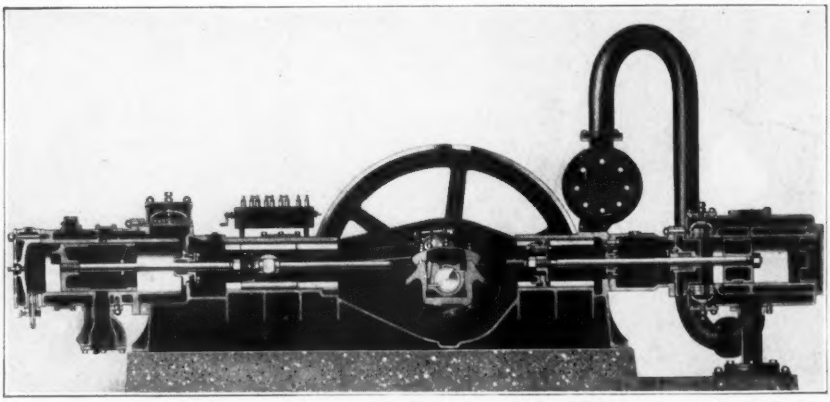
Carbon, as an essential element in the make-up of any petroleum product is present in more or less intimate chemical connection with hydrogen. There is a distinct difference between carbon as it exists in this manner and carbon as it is found in actual operation in the form of coke or carbon residue. In the former instance the complex hydrocarbons are largely in liquid or vapor form. The liquids where properly segregated have a high degree of oiliness, and hence have proved to be most adaptable lubricants. Coke or carbon residue developed as a result of break-down of certain of these hydrocarbons under high temperature, however, has no lubricating value whatsoever. In fact, the resultant material is even a particularly poor grade of carbon, so abrasive as to do a considerable amount of damage to the working parts.

It is interesting to note that the more nearly naphthenic base oils have been found to give a carbon residue of a comparatively soft, fluffy nature, which normally can be easily removed by brushing. It is reasonable to presume that carbon of this nature will oftentimes be very largely removed from the engine by the exhaust



Courtesy of The Cooper-Bessemer Corp.

...en compressor shown in Figure 5, note the method of installation of the lubricating equipment



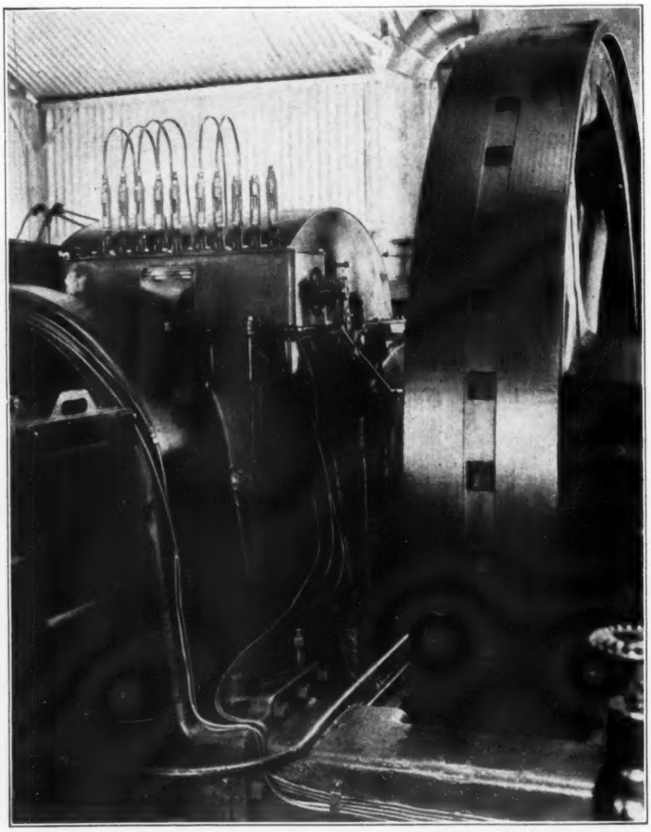
Courtesy of The National Supply Co. of Delaware, Superior Engine Division

Fig. 7—Sectional view of a Superior horizontal direct gas engine driven duplex compressor. A feature of this design is the ability to operate on two grades of lubricating oil, i.e.:
1. A highly refined product suitable for all bearings and external moving parts, and
2. A cylinder oil suitable for both power and compressor cylinders.

before it has a chance to accumulate within the latter. On the other hand, certain paraffin base oils if not properly refined will develop a carbon residue which will be of a comparatively hard and adhesive nature. Their use may lead to serious accumulations which may require virtually complete engine overhaul for their removal.

Effect on Power

Accumulation of carbon deposits in the gas engine will be primarily indicated by loss of power, and a tendency to develop knocking, according to the manner in which the fuel is handled. As a result, it will be essential for the operator to pay strict attention to the power out-put and sound of his engine. Power out-put can be readily observed in connection with such an engine, in view of the fact that it is stationary and therefore readily adapted to the installation of power measuring instruments.



Courtesy of Hills-McCanna Co.

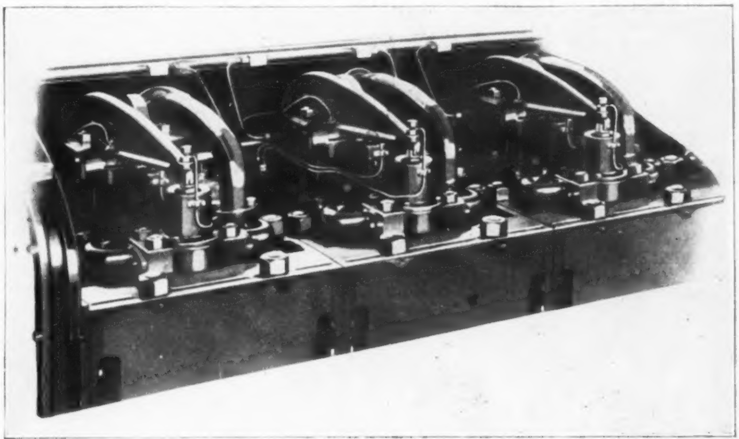
Fig. 8—A 26 pint 6 feed Hills-McCanna impulse type force feed lubricator equipped with metering sight feeds oiling 6 points on the two power cylinders of a 175 H.P. Cooper-Bessemer gas engine driven compressor.

Carbon Also Causes Pre-Ignition

The tendency of carbon deposits to become incandescent may be the cause of pre-ignition or back-firing in the gas engine. Back-firing will be indicated by an explosive noise in the intake or supply line. It may lead to reduction in power output if allowed to occur to an excess. It can frequently be corrected by analyzing the gas and studying the richness of the mixture to eliminate any tendency towards slow burning and the presence of lingering flame or incandescence in the combustion chamber to ignite the fresh charge of fuel prior to completion of the intake stroke and closing of the inlet valve.

Pre-ignition is chiefly caused by an

over-heated condition. Inasmuch as it involves explosion before completion of the compression stroke it is the direct cause of loss of power, due to the reverse energy exerted. If allowed to develop to an extreme, breakage of connecting rods or some other working part might occur. Pre-ignition will be indicated by a knocking noise. In view of the fact that it is caused by an overheated condition, one should study the carbon-forming tendencies of the lubricating oil, the ability of the cooling system adequately to reduce the cylinder wall and piston temperatures, and the dust content of the fuel. Both carbon and dust accumulations may become incandescent if the cooling system is inadequate, or if the cooling water is circulated at too high a temperature.



Courtesy of Ingersoll-Rand Co.

Fig. 9—The valve mechanism of an Ingersoll-Rand Rathbun type gas engine. All mechanisms are force feed lubricated which insures ample lubrication with minimum of waste, and elimination of hand oiling.

COMPRESSOR DESIGN

Natural gas is procured from wells which may or may not produce crude oil. Various pressures exist according to the locality and type of well. Instances are known where the well pressure at ground surface has run as high as 3000 pounds. While such gas, dependent upon the source, may be comparatively dry, in the green or wet form, it may contain from one-half to four gallons (per thousand cubic feet of gas) of so-called casinghead gasoline, or a heavier product, known as mineral seal oil which is similar to kerosine.

By reason of the nature of this gas, the horizontal reciprocating compressor, as widely used in casinghead gasoline manufacture, presents certain conditions of operation which may readily develop difficulties in lubrication. On the first stage, due to the vacuum which is maintained in the cylinder, there will be a tendency to draw oil off the piston rod as this oil is carried along the rod from the crankcase. To remedy this the piston rod stuffing boxes must be kept tight and in first class condition at all times.

In compression units used on the second stage, the rich gasoline vapors may condense and cause wash-off of the oil film on the cylinder walls, the liquid content tending to cut or dissolve the lubricating film, especially if this latter is a straight mineral product. The possibility of discoloration of the finished gasoline must also be considered. While this applies more particularly to higher stage units, in localities where the gas is green or quite rich in liquid ends, wash-off may also occur in the first stage or vapor unit. It is for this reason that compounded oils are preferred for cylinder lubrication of such machines; the same holds true where gas containing an appreciable amount of sulfur must be handled. To further assist in the maintenance of proper cylinder lubrication, some compressors are furnished with a lubricating connection not only into the cylinder itself, but also an extra connection into the gas intake port so that the suction valves are lubricated. Additional lubricant is thereby taken into the cylinder in finely atomized state along with the gas itself.

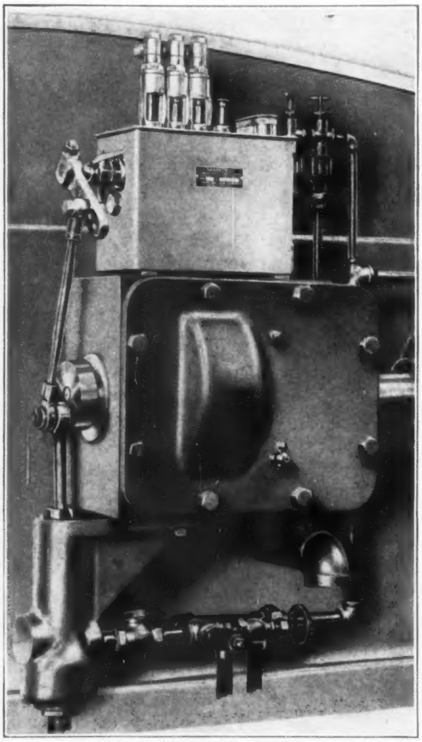
Where sulfur may exist in the corrosive form, the effect upon compressor parts must be considered, and the lubricant chosen for its protective as well as its lubricating properties.

Staging as understood in the handling of casinghead gases, however, must not be confused with the same term as applied to compressor design. Normally, single-stage compressors are used in the oil fields, being connected more or less in tandem in their handling of the gases under higher pressures.

From the viewpoint of compressor design, where but one stage of compression is employed, the compressor is known as a single-stage machine. It can be built both single and double acting and may be either horizontal or vertical, although as stated, the former is preferred in compression gas operations. Such machines are used for compression up to approximately 80 pounds. Vertical single-stage compressors are generally of the one cylinder, single acting variety. The piston in these machines is usually of the trunk type, the upper section carrying one or more rings which seal the cylinder

and prevent excess oil from being drawn in or splashed where they are designed for splash lubrication. The lower portion of the piston usually carries one ring only.

Horizontal single-stage compressors are like-



Courtesy of Worthington Pump & Machinery Corp.
Fig. 10—Showing application of a Manzel force feed lubricator to the Worthington horizontal double acting gas engine.

wise of the one cylinder, double acting type. Horizontal multi-stage reciprocating compressors, wherein the gas is subjected to two or more compressions, have a cylinder for each stage. Compressors of this type can be used when pressures in excess of 80 pounds are desired. In their operation, after initial compression in the first cylinder, the gas is passed through an intercooler, which serves to reduce the temperature; it is then compressed in a second cylinder and so on in succession until the desired compression pressure is attained.

In the handling of natural gas, following each stage of compression, and after-cooling, any liquid gasoline which is condensed is removed from the system by means of traps similar to those used on steam lines for the removal of water.

Lubrication Requirements

As a general rule, lubrication of wet compressors, where more or less of the product is in the liquid state, will require more careful consideration than where dry gas is involved, for the reason that the washing action of the liquefied gas on the cylinder walls may affect the maintenance of a suitable film of oil, as already stated.

Compounded Oil for Wet Gas Operations

The condition which exists is much the same as that which is encountered in the lubrication of steam cylinders where saturated steam is used. Just as in steam cylinder lubrication, straight mineral oils will be less resistant to this washing action than lubricants containing a small percentage of fixed oil, animal or vegetable compound. Lard oil, for example, has proved its value in this regard in compressor cylinder lubrication, just as it has in steam service.

The actual reaction in a gas compressor cylinder, however, is somewhat different than in a steam cylinder. In the latter a lather is developed by reaction of the moisture content of the steam with the fixed oil in the lubricant. Where gas is being handled, on the other hand, this fixed oil, being more adhesive and less soluble in liquid gas, sticks more tenaciously to the cylinder walls, at the same time promoting the adhesiveness of the mineral oil components of the compressor oil. This is of distinct advantage where the gas may contain sulfurous compounds, lard oil having been found to be the most efficacious compound under such conditions.

The amount of fixed oil compound to use in a compressor oil will, in general, be governed by the so-called moisture content of the gas. Normally 3% of lard oil will suffice to promote maintenance of an adequate film of lubricant, provided it is properly compounded with a highly refined mineral oil. On the other hand, when the gas is excessively wet, the use of from 10 to 20 per cent of rapeseed oil in compound has been found to promote effective lubrication, especially when used with a comparatively heavy mineral oil base.

The viscosity of this latter should be studied with due regard to the compression pressures, varying from 500 to 750 seconds Saybolt at 100 degrees Fahr. Use of the heavier viscosity has been found to promote economy in the amount required. Furthermore, it can be assumed to be more adhesive, especially under casinghead gasoline extraction operations, or wherever a considerable amount of liquid gas is present or developed in the course of compression. One should guard against the use of oils heavier than 750 seconds viscosity, however, due to the possibility of formation of deposits on cylinder walls and valves which might lead to retarded valve action and ex-

cessive wear of cylinder walls and piston rings, one must also consider the high silica content of such deposits, especially around natural gasoline plants.

Dry Gas Requires Straight Mineral Oils

Lubrication of gas compressor cylinders operating on dry gas will be essentially the same as where air is being handled. On the other hand, compression of natural gas does not require high pressures, therefore, temperatures are lower than in average air compressor service. For this reason heavy bodied oils are not required, a straight mineral 300 to 500 viscosity product being suitable. Under higher pressures, however, temperatures of compression will be increased just as in the case of air compressor operation. Normally these will not exceed 350 to 400 degrees Fahr. Under such temperatures the 500 second viscosity oil could be expected to give best economy and resist reduction in film tenacity, due to the higher temperatures. It is essential to remember, however, that the oil must always be of the highest degree of refinement, otherwise objectionable carbon deposits and gummy matter may develop, especially where an oil of the heavier viscosity is used. Where the gas being compressed is free from soot or other impurities, the sparing use of a properly refined straight mineral oil will insure efficient operation indefinitely.

The mechanical force feed lubricator has been proved a most adequate means of delivering oil to compressor cylinders, in as nearly as possible the right amount, commensurate with the nature of the gas, to insure dependable and continuous operation.

STORAGE AND HANDLING OF LUBRICANTS

To be complete, a study of the lubrication requirements of natural gas machinery requires consideration of storage methods and facilities for handling. Initial protection is most essential. As a result, wherever a considerable volume of lubricants are used a central location for oil storage is advisable. From such a point lubricants can be issued on requisition, and in suitable though not excessive quantities. In turn, all new supplies should be delivered here for storage until required, in order to insure the utmost protection against contamination.

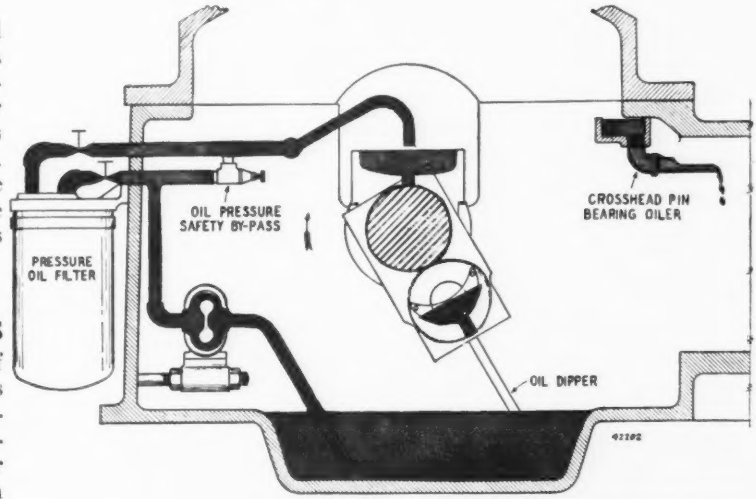
Many plants which are adjacent to oil supply stations frequently set aside a corner of the engine room or store-house for the storage of lubricants and keep them in shipping containers until empty, when they are returned to the oil dealer.

Wherever practicable the platform of the oil house or storage room should be on a level with the average car floor, or, where containers are to be delivered by motor truck, on a level with the floor of the average truck, to enable "one level" handling. Under such conditions, containers can be handled directly from the point of delivery to storage with a minimum of labor, damage, or time lost.

Constructional Details

The general construction of any oil house or storage compartment should be fireproof throughout, with brick, tile or concrete walls and floor. The roof or ceiling should be tile, metal or slate on steel beams or rafters. The danger of fire in modern oil storage will usually be negligible; yet constructional features of fireproof nature are the best of insurance, and first cost, unless prohibitive, should not be spared. In addition, cleanliness will be more easily maintained.

Doors and windows also require consideration. Best practice recommends as few of these as possible, and those that are used should be of steel-frame or roller type, fitted with wire glass and automatic closing devises.



Courtesy of Ingersoll-Rand Co.

Fig. 11—The oiling system as designed for the Ingersoll-Rand X.V.G. gas engine driven compressor. In this design a gear pump takes oil from the crankcase, forces it through the filter and then delivers an excess of clean oil to each main bearing cap. Overflow from these caps on to the crank cheeks is picked up by the oil catchers at each end of the hollow crankpins and is thrown on to the crankpin bearings by centrifugal force.

Tankage and Methods of Handling

With an understanding as to the requisite features of a modern oil house or storage room, the matter of storage tanks and their appurtenances becomes of interest. In any plant the type, size or number of storage tanks will depend upon the volume of lubricants which must be stored, and the number of different grades of lubricants necessary for plant operations.

The location of these tanks with respect to the delivery level is important where bulk transportation is customary. Package delivery of lubricants in drums, barrels, or cans, will be facilitated if gravity is made use of as far as possible.

Wasteful or sloppy handling of lubricants can frequently be prevented by care in control of oil house and tank temperatures. Where ready fluidity is assured less time will be required in drawing oil supplies. Facilities for heating are especially beneficial, wherever heavy, viscous products such as gear and chain lubricants are to be stored in bulk.

Heating of semi-solid lubricants to facilitate handling can be effectively accomplished by surrounding the exterior of the tanks with hot water coils near the suction or draw-off line. Thus heating of the entire tank is avoided.

Complete protection of lubricants in storage, however, is not entirely assured by proper construction and tank design; auxiliary equipment for the handling of the products must be given careful attention. This will involve pumps, meters or other measuring devices, conveying equipment, and portable elevators for hoisting or lowering containers.

For the handling of fluid lubricants out of any form of storage tank, sealed pumps should be used wherever practicable. Pumps for this purpose are built in many cases to meter or measure automatically the amount of oil withdrawn. A measuring device of some sort is always advisable in order that the oil consumption of the plant or any of its machines can be checked wherever desired. Measuring pumps will save considerable time and labor, will enable the personnel to fill orders promptly, and will insure that the oils are kept free from contamination and in their original state of purity until required in the plant.

The value of orderly procedure and properly kept records of daily, weekly and monthly oil consumption, should never be underestimated. The effect on the morale of the plant and the economies in consumption of lubricants that can be attained will be surprising, where accurate records of consumption are kept and where employees must follow a definite routine in obtaining their necessary oil supplies.

Contamination will be most apt to occur in the distribution of lubricants from storage to the various units to be served. As a general rule, the manner of distribution depends upon the location and number of units. In average plant service, manual handling will suffice, due to the relatively compact layout. Usually it will be found advisable to supply individual departments with sufficient gallonage at a time in order to reduce labor and transportation expense.

Where auxiliary storage in individual localities is to be maintained the type of containers used is important. Preferably they should be of the cabinet type of storage tank, fitted with a suitable hinged cover to afford the utmost protection of the contents. Such tanks should be equipped with measuring pumps, and so built that any drip from the pump discharge drains right back into the tank in order to avoid waste and sloppiness.

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